(19) Canadian Intellectual Property Office
An Agency of Industry Canada

Office de la Propri,t, Intellectuelle du Canada
Un organisme d'Industrie Canada

(11) CA 2 292 252 (13) A1

(40) 12.04.2001
(43) 12.04.2001

(12)

(21) 2 292 252

(51) Int. Cl.7: H04Q 7/36, H04L 12/56

(22) 14.12.1999

(30) 09/416,388 US 12.10.1999

(71) TELEFONAKTIEBOLAGET LM ERICSSON, S-126 25, STOCKHOLM, XX (SE).

(72) MARCHAND, LAURENT (CA).
LEMIEUX, YVES (CA).

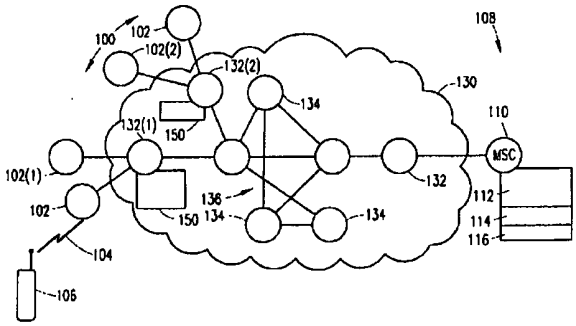
(74) MARKS & CLERK

(54) SYSTEME ET METHODE DE FONCTIONNEMENT D'UN ROUTEUR DE BORDURE A ETIQUETTES SPECIFIQUE AU SERVICE MOBILE AU SEIN D'UN RESEAU A STATION CENTRALE ET STATIONS PERIPHERIQUES

(54) SYSTEM AND METHOD FOR MOBILE SPECIFIC LABEL EDGE ROUTER OPERATION WITHIN A CORE AND EDGE NETWORK

(57)

A server switching node is connected to a client radio access network through a packet switched communications network. The packet switched communications network supports multiple protocol label switching (MPLS) at each included edge router and switch roister. At the interface with the client radio access network, the packet switched communications network utilizes a "mobile specific" label edge router (MLER) configured with mobility management functionality to support the handing over of a call from a label switched path to a first MLER associated with a currently serving radio base station to another label switched path for a second MLER associated with a target base station.



OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA

CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE

(12) (19) (CA) **Demande-Application**

(21) (A1) **2,292,252**

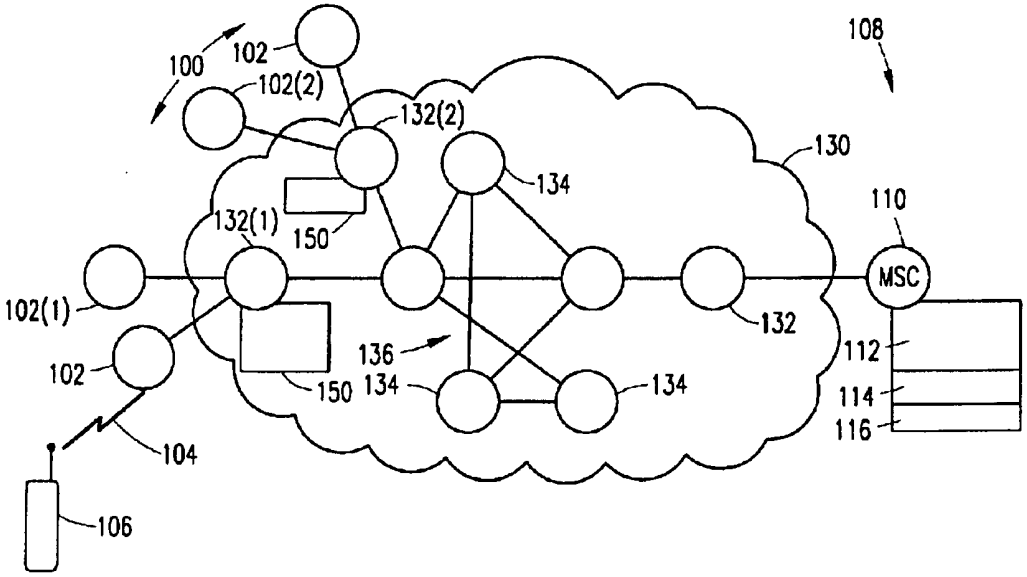
(22) 1999/12/14
(43) 2001/04/12

(72) MARCHAND, LAURENT, CA
(72) LEMIEUX, YVES, CA
(71) TELEFONAKTIEBOLAGET LM ERICSSON, SE

(51) Int.Cl.[7] H04Q 7/36, H04L 12/56
(30) 1999/10/12 (09/416,388) US

(54) **SYSTEME ET METHODE DE FONCTIONNEMENT D'UN ROUTEUR DE BORDURE A ETIQUETTES SPECIFIQUE AU SERVICE MOBILE AU SEIN D'UN RESEAU A STATION CENTRALE ET STATIONS PERIPHERIQUES**

(54) **SYSTEM AND METHOD FOR MOBILE SPECIFIC LABEL EDGE ROUTER OPERATION WITHIN A CORE AND EDGE NETWORK**



(57) A server switching node is connected to a client radio access network through a packet switched communications network. The packet switched communications network supports multiple protocol label switching (MPLS) at each included edge router and switch roister. At the interface with the client radio access network, the packet switched communications network utilizes a "mobile specific" label edge router (MLER) configured with mobility management functionality to support the handing over of a call from a label switched path to a first MLER associated with a currently serving radio base station to another label switched path for a second MLER associated with a target base station.

ABSTRACT OF THE DISCLOSURE

A server switching node is connected to a client radio access network through a packet switched communications network. The packet switched communications network supports multiple protocol label switching (MPLS) at each included edge router and switch router. At the interface with the client radio access network, the packet switched communications network utilizes a "mobile specific" label edge router (MLER) configured with mobility management functionality to support the handing over of a call from a label switched path to a first MLER associated with a currently serving radio base station to another label switched path for a second MLER associated with a target base station.

SYSTEM AND METHOD FOR MOBILE SPECIFIC LABEL EDGE ROUTER OPERATION WITHIN A CORE AND EDGE NETWORK

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to wireless packet switched communications networks and, in particular, to the operation of "mobile specific" label edge router (MLER) devices within a core and edge type wireless packet switched communications networks.

Description of Related Art

Reference is now made to FIGURE 1 wherein there is shown a block diagram of a core and edge type packet switched communications network 10 in accordance with the prior art. The network 10 is comprised of a plurality of edge routers 12

and a plurality of switch routers 14 that are interconnected 16 in at least an almost fully-meshed network configuration. Some of the switch routers 14 support connections to the edge routers 12.

The edge routers 12 and switch routers 14 of the core and edge type network 10 comprise packet switched nodes implementing a legacy switching technology (such as, for example, frame relay, ethernet, or asynchronous transfer mode (ATM)) at OSI data link layer 2. Communication over the network 10 utilizes transaction control protocol (TCP) or user datagram protocol (UDP) over internet protocol (IP) at OSI network layer 3. The physical (PSY) connection between the nodes provided by OSI layer 1 may comprise any suitable connection such as, for example, T1, fiber optics, microwave links, coaxial cable, and the like.

The edge routers 12 and switch routers 14 of the core network 10 further implement multiple protocol label switching (MPLS), and thus are commonly referred to as label edge routers (LERs) and label switch routers (LSRs). An MPLS packet 20 is illustrated in FIGURE 2. The packet 20 encapsulates an IP packet 30 (see, FIGURE 3). The packet 20 includes a label portion 22 and a payload portion 24. The label portion 22 is relatively small (in the order of four

bytes) in comparison to the IP packet header portion 32, and includes a number of pieces of information in fields as is well known in the art that are used in efficiently routing the packet through the network 10. This effectively hides the complexity (in terms of processing) of the IP header 32, and replaces it with the smaller, and more easily processable, label 22 to convey the IP payload 34. The label edge routers and label switch routers operate to route the MPLS packets 20 based on the contents of the label portion 22 rather than on the contents of the IP packet 30.

The general benefits which accrue from the use of such MPLS configured packet switched networks 10 are well know. Application as a core network for interconnecting a mobile telecommunications network server (like a mobile switching center (MSC)) to the mobile telecommunications network clients (like base stations (Bss) and their associated mobile stations (MSs)), however, presents a number of difficulties that stem primarily from concerns over supporting client mobility. One reason for this is that as mobile stations travel and their calls are handed off from one base station to another base station, the conventional label edge router operation is not capable of performing the mobility management functions necessary to hand over a label switch path from one label edge

router to another label edge router and thus enable continued support of the call. What is needed then is a method and system for configuring a label edge router (and more generally, the associated packet switched network) with these needed mobility management functions. Put another way, what is needed is a "mobile specific" label edge router (MLER) for use in a core and edge type packet switched network that interconnects servers and clients in a wireless telecommunications network.

SUMMARY OF THE INVENTION

A packet switched communications network connects a server switching node to a client radio access network. The packet switched communications network supports multiple protocol label switching (MPLS) at each included edge router and switch router. At the interface with the client radio access network, the packet switched communications network utilizes a "mobile specific" label edge router (MLER) configured with a mobility management functionality that supports the handing over of a call from a label switched path for a currently serving MLER associated with a currently serving radio base station to another label switched path for a different MLER associated with a target base station.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be acquired by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1, previously described, is a block diagram of a prior art core and edge type packet switched communications network;

FIGURE 2, previously described, is a format diagram for a multiple protocol label switching (MPLS) packet;

FIGURE 3, previously described, is a format diagram for an IP packet;

FIGURE 4 is a block diagram of a client/server environment wireless communications network in accordance with the present invention; and

FIGURE 5 is a flow diagram for a mobility and traffic management procedure implemented in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIGURE 4 wherein there is shown a block diagram of a client/server environment wireless communications network in accordance with the present

invention. In providing wireless communications services, the clients 100 comprise a plurality of base stations 102 that support subscriber communications over an air interface 104 with a plurality of mobile stations 106. The server 108 comprises a mobile switching center 110 having functionalities for network signaling and control 112, gateway operations 114 for interfacing the network to the Internet or an intranet, and service provision 116 for supporting subscriber access to services such as, for example, voice mail, intelligent networking (IN), and the like. Interconnecting the clients 100 to the server 108 is an MPLS packet switched core network 130 (see, generally, FIGURE 1) comprised of a plurality of edge routers 132 supporting connections to the base stations 102 and the mobile switching center 110, and a plurality of switch routers 134 that are interconnected 136 in at least an almost fully-meshed network configuration. Some of the switch routers 134 support connections to the edge routers 132.

The edge routers 132 and switch routers 134 of the MPLS core network 130 comprise packet switched nodes implementing a legacy switching technology (such as, for example, frame relay, ethernet, asynchronous transfer mode (ATM), giga-byte routers, IP-over-WDM routers, and the like) at OSI data link layer 2. Communication over the network 130 utilizes

transaction control protocol (TCP) or user datagram protocol (UDP) over internet protocol (IP) at OSI network layer 3. The physical (PSY) connection between the nodes provided by OSI layer 1 may comprise any suitable connection such as, for example, T1, fiber optics, microwave links, coaxial cable, and the like.

The edge routers 132 and switch routers 134 of the core network 130 implement multiple protocol label switching (MPLS), and thus are commonly referred to as label edge routers (LERs) and label switch routers (LSRs). These label edge routers 132 accordingly function in conventional fashion to provide differentiated services (through use of the class of service (CoS) field within the MPLS packet label), and also function to terminate label insertion and extraction so that the MPLS labels do not propagate outside the core-edge network 130 (excluding, therefore, the mobile stations). In accordance with the present invention, the label edge routers 132 used to make the connection with the server-side radio access network (comprising the plurality of base stations 102 that support subscriber communications over the air interface 104 with the plurality of mobile stations 106) include an additional mobility management functionality 150. Using this mobility management functionality 150, a label edge router 132

(referred to herein as a "mobile specific" label edge router, or MLER) supports mobile station 106 mobility by performing or controlling, when necessary, hand over of a call from one label switched path (LSP) for a first MLER to another LSP for a different MLER. In this way, continuity of call provision may be maintained in the packet switched environment as the mobile station 106 travels throughout the network. Put another way, the mobility management functionality 150, in conjunction with any implicated network management service implemented at the server 108, handles the call hand over from a label switched path for a first MLER 132(1) associated with a currently serving base station 102(1) to another (pre-defined) label switched path for a second MLER 132(2) associated with a target base station 102(2).

Essential to label switching is the notion of binding between a label and network layer (OSI layer 3) routing (or routes). A control component is responsible for creating label bindings and then distributing the label binding information amongst the routers. Label assignment involves allocating a label, and then binding the label to a route (or path).

The set of procedures and messages used by label switch routers 134 to establish label switched paths through the

network 130 are commonly referred to in the art as a label distribution protocol (LDP). These procedures and messages operate to map network layer (OSI layer 3) directly to data link layer (OSI layer 2) switched paths. This is accomplished using labels 22 (see, FIGURE 2). Labels are used to create a simple forwarding paradigm. The essential element in assigning a label is that the device (such as the label switched router) that will be using the label to forward the MPLS packets, will forward all packets with the same label in the same way. If the packet is to be forwarded solely by looking at the label, then it follows that at a minimum all packets with the same incoming label must be forwarded out the same port(s) with the same encapsulation(s), and with the same next hop label. This, in effect, defines the label switched path. In the context of the this invention, each packet of a given session of the mobile terminal shall have the same incoming label.

There are four commonly utilized categories of LDP messages. The first is a "discovery" message which is used to announce and maintain the presence of a label switched router within the network. The second is a "session" message which is used to establish, maintain and terminate sessions between LDP peers. The third is an "advertisement" message which is

used to create, change and delete label mappings for forward equivalent classes. The fourth is a "notification" message used to provide advisory information and to signal error information.

With respect to the operation of the mobility management functionality 150 of the present invention, the message category of most interest relates to the "session" message. Using new message types within the "session" category, the mobility management functionality 150 operates to predefine and set up label switched paths through the various included MLERs 132. These label switched paths then provide pre-allocated resources that can be managed in terms of label spaces by the mobile specific label edge router (MLER) to effectuate hand over of packet switched calls. What is needed in that context is to simply have the call transferred by the network from the serving label switched path (allocated to the currently serving MLER and its associated serving base station) to another (predefined) label switched path (allocated to another MLER associated with the target base station). This is accomplished by modifying the label data in the MPLS header for the call data to identify the label switched path to be used after hand over is completed. For that purpose, new LDP messages are proposed for use in setting

up a predefined label switched path and also for use in tearing down from a predefined label switched path.

The advantages of the present invention may be better understood by reference to a specific example. Consider the general packet radio services (GPRS) provided within the global system for mobile (GSM) communications. More specifically, attention is directed to operation of the serving GPRS switching node (SGSN) which in the FIGURE 4 environment comprises a mobile specific label edge router. With respect to micro-mobility (i.e., hand over), the GPRS tunneling protocol (GTP) is currently used to tunnel (or encapsulate) user data and signaling between GPRS support nodes and the GPRS backbone network. In this context, all packet data units (PDUs) are encapsulated by the GTP. This operation is well known to incur some extensive delay while handling a hand over operation. The use of MPLS, in conjunction with the operation of the mobility management functionality 150, improves this situation by providing predefined label switched paths for immediate selection at hand over. This operation substantially alleviates the extra time that would have to be expended at hand over to set up the tunnels required to handling the call following hand over. Instead of tunneling, as with the prior art GPRS operation,

the step of tunneling set up is replaced with the more efficient operation of switching to a predefined label switched path associated with the target base station.

Reference is now made to FIGURE 5 wherein there is shown a flow diagram for a mobility and traffic management procedure implemented in accordance with the present invention. In step 200, each mobile specific label edge router identifies its neighbors (i.e., those other MLERs that most like would comprise targets for hand over) and registers itself with the network management system of the server. In step 202, each mobile specific label edge router determines through pre-provisioning setups the applicable preferences in terms of mobile station registration (macro-mobility), hand over (micro-mobility), call setup, call supervision, call tear down, mapping of sessions to label switched paths, and the like. Next, each mobile specific label edge router ramps-up in step 204 to required load conditions while sharing operation and maintenance (O&M) management information with the transport network management system (TNMS) part of the network management system (NMS) within the server. In the meantime, call supervision is kept running in the background in step 206. In step 208, a determination is made as to whether there is a malfunction condition on a certain label

switched path. If so, in step 210 the path is duplicated (i.e., an alternative LSP) and service is switched over to that path without degradation. The process then returns to step 204. If not, the process proceeds to evaluate in step 212 virtual connection (VC) usage to see if VC merging should be rearranged in step 214. The process then returns to step 206.

Although preferred embodiments of the method and apparatus of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

WHAT IS CLAIMED IS:

1. A mobile communications system, comprising:

a mobile switching node;

a mobile radio access network comprising a plurality of base stations capable of supporting radio frequency call communications with mobile stations; and

a multiple protocol label switching (MPLS) packet switched network interconnecting the mobile switching node to the mobile radio access network, the packet switched network including a plurality of interconnected label switch routers and a plurality of label edge routers connected to ones of the packet switch routers, wherein an interface to the mobile radio access network is made through at least two mobile specific label edge routers each having a mobility management functionality that supports the handing over of a call from a label switched path for a first MLER associated with a currently serving base station to another label switched path for a second MLER associated with a target base station.

2. The system as in claim 1 wherein the routers comprise asynchronous transfer mode (ATM) routers.

3. The system as in claim 1 wherein the label switched paths are predefined and then selected at each instance of hand over.

4. The system as in claim 1 wherein call data is carried in an MPLS packet including a header portion having a label fields mapped to a certain label switched path, and the process of handing over includes changing the label fields of each call packet to reflect the other label switched path.

5. The system as in claim 4 wherein the MPLS packet further includes a payload portion containing an internet protocol packet having a payload portion comprising the call data.

6. A label edge router for use in a multiple protocol label switching (MPLS) packet switched communications network, comprising:

an interface to at least one base station of a radio access network; and

a mobility management functionality that supports the handing over of a call from a label switched path for the label edge router and associated with a certain one of its interfaced base stations currently serving a mobile station to another label switched path for a different label edge router associated with a target base station that will serve the mobile station following hand over.

7. The router as in claim 6 wherein the router implements asynchronous transfer mode (ATM) networking.

8. The router as in claim 6 wherein the label switched paths are predefined and then selected at each instance of hand over.

9. The router as in claim 6 wherein call data is carried in an MPLS packet including a header portion having a label fields mapped to a certain label switched path, and the process of handing over includes changing the label fields of each call packet to reflect the other label switched path.

10. The router as in claim 9 wherein the MPLS packet further includes a payload portion containing an internet protocol packet having a payload portion comprising the call data.

11. The router as in claim 9 wherein the label edge router terminates further propagation of label fields contained in received MPLS packets.

12. A mobility and traffic management process for implementation by a mobile specific label edge router (MLER) operating within a multiple protocol label switching (MPLS) packet switched communications network interconnecting a mobile switching node to a radio access network serving a plurality of mobile stations, comprising the steps of:

identifying its neighboring MLERs and registering itself with a server network management system;

determining through pre-provisioning setups any preferences relating to mobile station registration, hand over, call set up, call supervision, call tear down and mapping of sessions to label switched paths;

ramping up to required call load handing conditions;

detecting a malfunction condition on a label switched path and responding by switching over to a duplicate label switched path; and

evaluating virtual connection usage to determine if virtual connection merging should be arranged.

13. The method as in claim 12 further including the step of running a call supervision functionality in the background.

14. A method for call hand over, comprising the steps of:

pre-defining plural label switched paths through a multiple protocol label switching (MPLS) packet switched communications network to its connected label edge routers;

handling of a mobile call on a first one of the label switched paths for a first label edge router associated with a first base station of an interfaced radio access network;

detecting a need to hand over the call to a second base station of the radio access network wherein that second base station is associated with a second label edge router; and

handing over the call from the first label switched path to a second one of the label switched paths for the second label edge router.

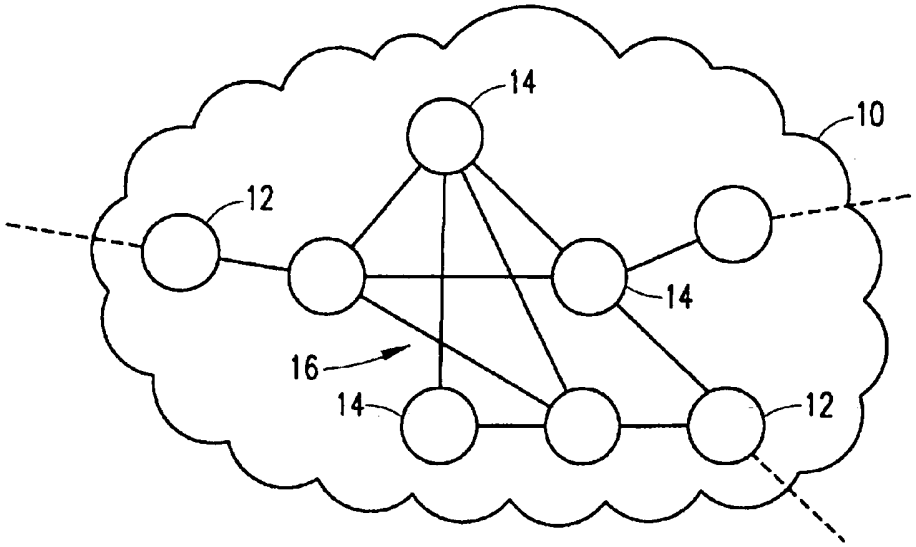


FIG. 1
(PRIOR ART)

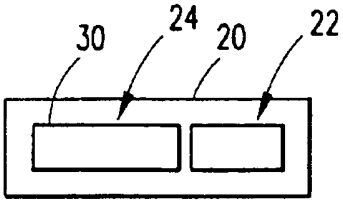


FIG. 2
(PRIOR ART)

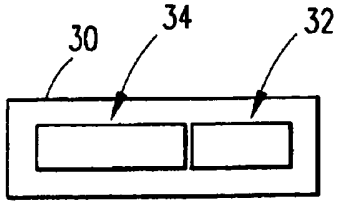


FIG. 3
(PRIOR ART)

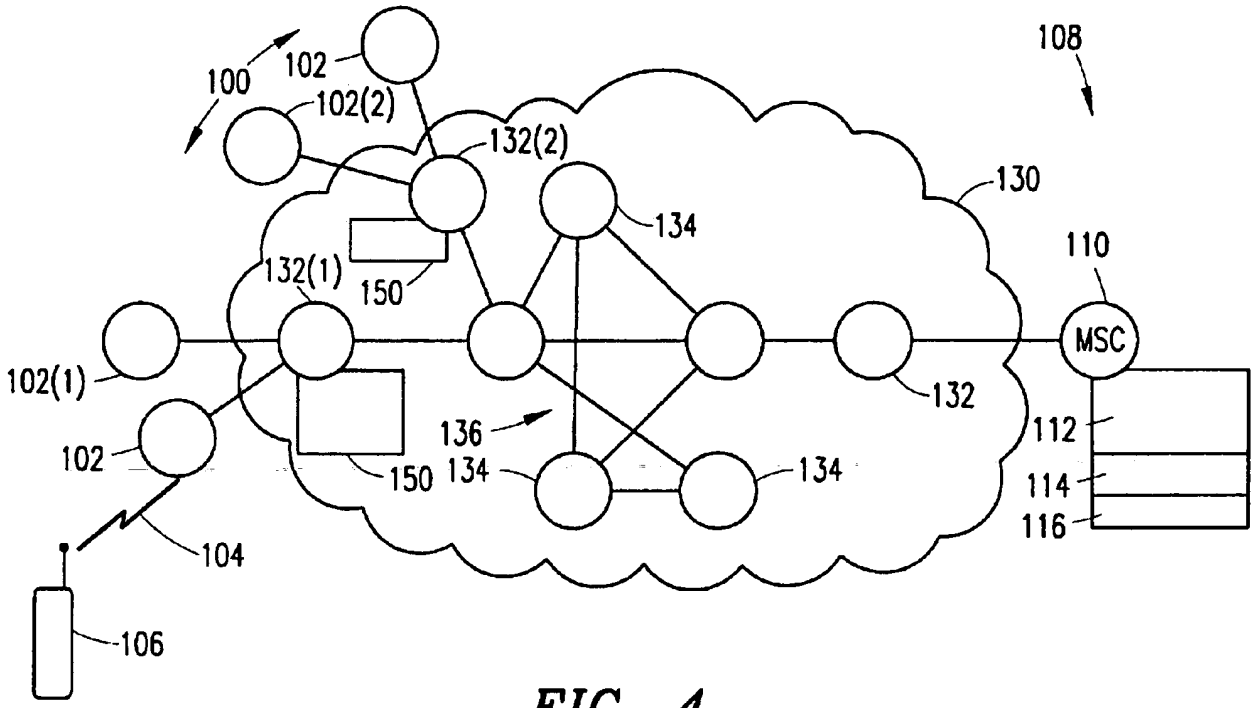

100
102
102(2)
132(2)
108
130
134
110
132(1)
150
MSC
102(1)
132
112
102
136
150
134
134
114
116
104
106

FIG. 4

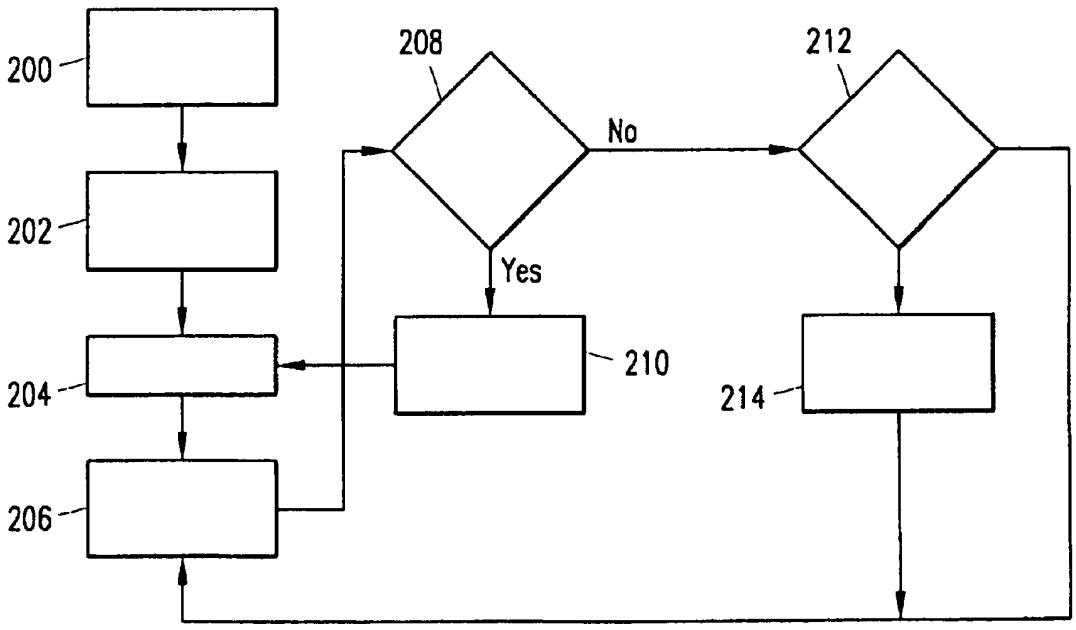

200
208
212
No
202
Yes
210
204
214
206

FIG. 5